Multi-User, Multi-Finger Drag & Drop of Multiple Documents

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Abstract
With the availability of new input devices such as DiamondTouch [1], multiple users can now interact with a 2D surface using both hands and/or multiple fingers simultaneously. From our experience in working on multiple preferred orientations of documents in an augmented tabletop environment [2,3], we noticed that the orientation of documents on the table and the number of users are not the only entities that naturally present multiplicity and concurrency. In this paper we present our vision on how users can use more than one fingers to collaboratively manipulate multiple documents in parallel.

Research Vision
Multiple mice input methods and the effect of multiple mice for supporting co-located collaboration have been previously investigated in the context of Mmouse [maryland Mmouse] and SDG (Single Display Groupware) [4,5]. These studies were all based on systems using a vertical desktop display. It is common practice for multiple people working at a physical horizontal table to pass and share objects among each one another in various ways, such as (a) handing over a particular object from one person to another person, (b) two people holding the same object for joint viewing, and (c) exchanging multiple objects among each one another simultaneously. The research question we would like to address is, "What kinds of functions should an interactive tabletop environment offer to allow these natural styles of object sharing. ?" Drag & drop is an UI paradigm of direct manipulation proposed by Ben Shneiderman [7], but it has not evolved further since then. Our goal is to investigate scenarios that could become the paradigm of direct manipulation in the context of a tabletop collaborative system.

Scenarios
The following are four multi-user multi-finger scenarios we plan to study. These scenarios occur in situations in which User A clicks/selects and starts to move a document with his pointing device while User B clicks on the same document, on the fly, before User A drops that document.

- ✍ **Stealth** – Based on prior agreement, ownership/control of the document is transferred from User A to User B. In this case, the tabletop system can use the pointer of User B as the new guide for the document.
- ✍ **Protected** – User A continues to own/control the document, thus denying control to User B. This scenario also handles the case when User B mis-clicks/mis-selects a document that is immediately near the one User A is drag & dropping. Thus, in this scenario, the selection action by User B has no effect on the ownership of the document in question.
- ✍ **Forced Negotiation** - Document movement is frozen until one of the two users decides to voluntarily relinquish control and drop the document.
- ✍ **Exchange** – Exchange is an extension of Forced Negotiation. In this case, User A initially possesses Doc1 and User B possesses Doc2 with only one hand respectively, while, at the same time, each user using the other hand clicks/selects the other user's document. When one of the two users drops/gives up the document it initially possessed, the exchange of ownership occurs. User A now

owns Doc2 and User B now owns Doc1).

These scenarios are only a first set of our study. We have already implemented the stealth, the protected and the forced negotiation scenario with a DiamondTouch tabletop using DiamondSpin [2,3]. The multi-finger exchange scenario will be our next step.

General Conflict Resolution of Documents

The above scenarios exemplify conflict resolution schemes that we have found to be useful in the context of our multi-user DiamondSpin applications. The issue of conflict resolution of concurrent document access is one we would like to investigate further in other applications. For instance, some applications may benefit from schemes that implement physical haptic force in the user interface. E.g., a scheme that gives control to the user who most forcefully grabs the document may be appropriate in some situations. With DiamondTouch it is possible to mesure a difference in the area of contact when the finger (or hand) is pressed forcefully.

Mult- finger opportunity

The multi-finger scenario we want to investigate also raises another interesting issue. To explain it, let's come back to the single user paradigm of drag & drop. With two pointers, one user can drag two documents at the same time with two hands. It happens with real documents on physical tables, but the natural asymmetry of our two hands prompt us to use them differently. The strong/preferred hand picks up documents and passes them to the weak hand. The documents accumulated in the weak hand behave like a FILO stack. Such a scenario can also be realized with computational multi-input devices. We envision interesting consequences on multi-user versions of this multi-hand stacking drag & drop, probably very useful to organize, group and ungroup documents.

Workshop Issues

An important issue is to identify the differences between tabletop and vertical screen interfaces, and to combine them with the difference with Collaborative/Single user interfaces. It is also important to find a common design space and terminology on what is really new (for both hardware and software). During this process, another important issue is to understand whether we are merely reproducing thebehaviour of single user display based interface, the behaviour of real shared tables, or we have actually arrived at new and useful mechanisms. We are also seeking good application examples to demonstrate that our work proposed here is generally useful for co-located collaboration, not merely creating a “card game table”.

Current Research Direction

As part of the study of how to support co-located collaboration on a computationally enhanced tabletop interface, we proposed and built a prototype of an interface to handle multiple orientations of presented documents called DiamondSpin [2,3]. We first used a standard mouse, then a mimio stylus as the input device[6]. Currently our tabletop environment is ported onto DiamondTouch. With the experience of using DiamondTouch, we learned that not only the orientation of the documents must be considered differently for multiple users, but also the drag & drop operations. DiamondTouch allows two or more users to manipulate simultaneously with the interface. Our next step is to implement the multi-finger aspect in the event dispatching mechanism of our tool library for circular tabletop interfaces (DiamondSpin). Then we will carry out user studies on the different scenarios, gather comments, errors and suggestions. An other interesting perspective is to build a physical model of documents (weight, speed, and friction with the table) to let the user move document (or the whole table) with inertia.

Bio

Frederic Vernier is an assistant professor in the department of computer science at the University of Paris XI. His research interests are in information visualization (Fisheye views, Treemaps, etc.) and augmented interfaces (screens which behave like semi-mirror). He had his PhD at University of Grenoble (France) and then did a 18 months post-doc at MERL where he worked with Dr Chia Shen on circular tabletop interfaces.

Chia Shen is Associate Director & Senior Research Scientist at Mitsubishi Electric Research Labs, Cambridge Research. Her research spans from non-traditional off-the-desktop interactive user interfaces and HCI for multi-user applications, to distributed real-time systems and multimedia systems in wired and wireless networks. Her long term research interest is to facilitate and enrich our communication from both the network level and the HCI perspective. Her most recent research projects include DiamondSpin, Personal Digital Historian(PDH) and MidART (Middleware for Distributed Real-Time Systems).

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